

on the flanks, and by the blue colour of the beak and bright yellow of the cere and feet. It is now certain that the continuity or non-continuity of the bars of the tail is not of specific importance, as I originally thought. No further observations need be made here respecting the young and adult plumages of *F. Islandicus*, as in my former paper I described from birds shot at their breeding station, having in my possession a brood with their two parents. It therefore only remains to be shown that no change takes place in this species after it has attained its mature garb; and of this there is now sufficient evidence.

In August 1847 I received a living mature male Iceland falcon; it had not quite completed its first moult, having still a few of the nest feathers, and was a fine characteristic specimen. It died in June 1850, after having cast its feathers three times; and its last plumage was precisely similar to that of its first mature dress—being no whiter nor in the least changed in the markings. Another individual may be alluded to which was brought to England in 1846, and which I saw in November 1848, after it had completed its second moult. It was afterwards sent to the Zoological Gardens, Regent's Park, where I saw it again in the beginning of last year (1853); and though it must then have changed its plumage four times since I first examined it, there was no perceptible difference in its whiteness, or in the character of its markings. Other examples might be cited, for I have had many opportunities of seeing this species alive; but the above would seem quite sufficient to prove that the Iceland falcon undergoes no further change after having attained its mature plumage.

In conclusion it may be stated that the characters of the two forms are permanent and sharply defined, never blending into each other; and that the young as well as the mature birds can always be distinguished. But whether these two falcons are to be considered distinct species or mere races must depend upon the views entertained regarding what is to constitute specific character. For my own part I see no reason to doubt the correctness of the opinion I originally expressed.

## XII.—On the Structure of the Echinoderms.

By JOHANNES MÜLLER.

[Continued from p. 24.]

### *Ambulacræ of the Asteridæ.*

WITH the restriction of the ambulacræ to the ventral surface in the *Asteridæ*, all differences among the feet disappear. They are always locomotive and either conical, as in all *Asteridæ* without

an anus, *Astropecten*, *Luidia*, *Ctenodiscus*; or cylindrical with a sucking disc and without a calcareous plate, as in all those genera of *Asteridæ* which are provided with an anus. The discrimination of *Astropecten* from *Archaster* is therefore easy; it should be remarked, however, that it is often difficult at once to recognise the anus, though it is easy to do so, if in *Archaster* we remove the external crowns of the *paxillæ* in the middle of the starfish by which it is hidden, as the ground is by the foliage of closely planted trees. In *Astropecten Parelii*, v. D. et K. (Kongl. Vet. Acad. Handl. f. 1844, p. 247. tab. 7. figs. 14-16), the definiteness of this character was recently well exemplified. M. Sars had informed me that this *Astropecten* formed an exception to the law which I had enunciated with respect to the feet; I therefore concluded that this starfish would turn out to be no *Astropecten*, but an *Archaster*, a genus hitherto not known to inhabit the European seas. M. Sars has since that time furnished me with a specimen preserved in spirits, in which I at once discovered the anus, when the external crowns of the *paxillæ* were removed so as to render the skin of the back visible.

In comparing the *Asteridæ* and *Echinidæ* as Blainville and Agassiz endeavoured to do, we soon perceive that the inter-ambulacral plates, instead of being analogous in the two families, are quite differently arranged. It is not the marginal plates of the *Asteridæ* alone which lie between the radii, and the upper marginal plates are already dorsal.

In the *Asteridæ* we must distinguish different kinds of inter-ambulacral plates from one another. Those which rest upon the external processes of the ambulacral plates have a certain peculiarity as marginal plates of the ambulacra or *adambulacral plates*; they exactly agree in number with the ambulacral plates. To the second kind belong the more or less well-marked *marginal inter-ambulacral plates* at the peripheral edge, which are sometimes in single, sometimes in double series. Between the adambulacral and marginal there are often *intermediate* inter-ambulacral plates. In *Astropecten* this area is exceedingly small, and is reduced to a few easily overlooked plates behind the angles of the mouth; in the pentagonal forms it is very large. In form and size these plates often, as in *Astrogonium*, differ both from the adambulacral and from the marginal inter-ambulacral plates.

The marginal inter-ambulacral and the adambulacral plates extend to the end of the arms; the intermediate plates cease for the most part earlier. In those *Asteridæ* whose arms are round and whose margin is not developed, the series of plates which

marks off the dorsal pore-area from the ventral surface is the equivalent of the marginal plates. In these forms also the number of the series of plates from the groove of the arm to the pore-area varies very greatly; in some there are only two series of plates, the intermediate plates disappearing, as in *Echinaster* and *Scytaster*, whilst in *Ophidiaster* there are many series of plates between the groove of the arm and the pore-area, the outermost of which, as adambulacral plates and marginal plates, extend completely to the extremity of the arm, the others, as intermediate rows of plates, are more or less, and, indeed, gradually, diminished. It is obvious that the inter-ambulacral plates of the Sea-urchins and *Asteridæ* are differently, and, in fact, so differently disposed, as to give rise to the main distinctive peculiarities of a Sea-urchin and of a Starfish.

Still greater are the differences between the ambulacra of the *Asteridæ* and *Echinidæ* in the vertical direction. The nervous cord and the ambulacral canal of the *Asteridæ* lie, covered by the integument, over the mutually applied ambulacral plates, that is, upon the outer side of the vertebral processes of these plates; in the *Echinidæ*, however, they lie beneath the ambulacral plates on the inner surface of the shell. The vertebral processes of the ambulacral plates of the *Asteridæ* are absent in most *Echinidæ*, but in the *Cidaridæ* they have a perfectly analogous structure at the anterior extremity of the ambulacra, where the ambulacral plates on the inner side of the series of pores send off perpendicular processes into the cavity of the shell, between which lie the trunks of the ambulacral organs. The ampullæ are external. The clavate ends of a number of these processes unite to form a continuous colonnade, while they leave between their bases inter-vertebral passages, apertures for the branches given off by the ambulacral vessel to the ampullæ and the pores of the shell. There is no union of the vertebral processes of the right and left side. The analogy of the auricular processes at the anterior extremity of the corona of the Sea-urchins with the vertebral processes of the *Asteridæ*, which is remarked in the 'Anatomische Studien über die Echinodermen' (Archiv, 1850), is more apparent than universally true. The auricular processes are, indeed, in most Sea-urchins, processes of the ambulacral plates, and the ambulacral organs pass between them; but in *Cidaris* we meet with an exception, the inter-ambulacral plates giving off the auricular processes for the muscles of the jaws.

Besides *Cidaris*, *Clypeaster rosaceus* and *altus* (or the genus *Echinanthus* altogether) possess that part of the ambulacral plates which is analogous to the vertebral processes of the *Asteridæ* in the internal table of their ambulacral plates. In this

case all the ambulacral plates take a part in its formation, and the right and left portions are even united by a suture. This ambulacral floor lies, as in the *Asteridæ*, beneath the trunks of the ambulacral vessels and nerves. On the other hand, the external table of the ambulacral plates lies over the trunks of the nerves and vessels, like the membranous covering of the ambulacra of the *Asteridæ*. Herein we have sufficient evidence that in fact the structure of the ambulacra in the *Echinidæ* and *Asteridæ* is widely different, and *Cidaris* and *Echinanthus* may be considered to furnish the key to the proper understanding of these deviations.

The *Ophiuridæ* depart a step further than the *Asteridæ* from the Sea-urchins. The ambulacral plates have still retained their vertebral form in the *Ophiuridæ*, and the ambulacral canal runs in a groove over them; above the ambulacral vessel, however, lies the flat nervous cord of the arm, and above that are the peculiar plates, the ventral discs of the arms; but under the vertebral portions or analogues of the ambulacral plates there are no ampullæ, the latter structures being totally absent in the *Ophiuridæ*. The lateral branches of the ambulacral vessel pierce the ventral portion of the vertebral segment horizontally as far as the suckers, which are arranged along a groove of this part of the skeleton. Pores leading to internal diverticula, comparable to the ambulacral pores of the *Asteridæ* and Sea-urchins, are non-existent. The nervous trunk of the arm gives a branch to every sucker, for which an appropriate groove is excavated upon the ventral surface of the vertebral segment.

In comparing the Sea-urchins with the *Asteridæ*, particular interest attaches to the five plates of the apex of the former, which, from their position between the genital plates, have been called intergenital plates—a term long in use, for which Agassiz has lately substituted the name of ocellar plates, which I think almost too theoretical to be safely used. Each of these plates is situated at the end of an ambulacrum without being itself an ambulacral plate; it is pierced, and in the aperture the ocular bulb discovered by Forbes is situated. This body, the fact of whose existence has been confirmed by Agassiz and Valentin, and which I also have seen (in *Cidaris*), is the analogue of the coloured ocular spot discovered by Ehrenberg at the extremity of the arms of the *Asteridæ*. In both cases the nervous cord of the radius enters the bulb, passing in the Sea-urchins from within outwards, through the aperture in the plate. Agassiz justly lays very great weight on this analogy, and ascribes to the *Asteridæ* also an ocellar plate at the end of the ambulacrum, between which and the ambulacrum the new ambulacral plates are formed, as in the Sea-urchins. Here also the new inter-ambulacral plates

are formed at the point of the arms, but this can only hold good of those which reach the extremity of the arm. In most *Asteridæ* many series of plates do not attain the end of the arms, as in *Ophidiaster*, *Asteriscus*, *Astrogonium*. He supposes further, that the plate in question has the same relations in the *Asteridæ* as in the Sea-urchins, and that the eye is in the *Asteridæ* also seated in it (Ann. d. Sc. Nat. t. vi. 1846, pp. 309, 311). It is here presupposed that the radial nerve has an internal course underneath the ambulacral plates in the *Asteridæ* as in the *Echinidæ*, which, however, is true only of the latter and not of the former. Neither is there any aperture in the azygos plate which lies at the end of the ambulacrum and at the beginning of the dorsal part of the arm. The analogy of the plates in the Sea-urchins and *Asteridæ*, however, is not weakened, but is strengthened, by this circumstance. It is in all cases the terminal plate, the outermost of the radius. In the *Asteridæ*, which have large marginal plates developed in their peripheral border, it is the marginal plates, viz. the upper marginal plates, which have the same shape as this apical radial plate and form one series with it. The marginal plates are, therefore, in a manner repetitions of the apical plate of the radius, which unite the radii in festoons and separate the abdominal or inter-ambulacral side from the dorsal or antambulacral side. The terminal plate is smooth when the marginal plates are smooth (*Astrogonium*); in other cases, when all the inter-ambulacral and ambulacral plates are granulated (*Scytaster*, *Ophidiaster*), it is covered with granules. As the terminal piece of the arm, this plate has relations to the antambulacral as well as to the ambulacral and inter-ambulacral sides, and it is equally true for the antambulacral side that new plates are formed in its vicinity to extend those series which reach the end of the arm.

In the *Ophiuridæ* the terminal portion of the radius is a peculiarly formed articulation without either spines or suckers, between which and the next all the new articulations of the radius arise, as has been shown by the history of the development of the *Ophiuridæ*. This articulation is obviously the analogue of the terminal piece of the arm of the Starfishes. The mode in which the terminal articulation of the arm of the young Ophiurid is penetrated by the ambulacral canal, whose cæcal extremity is visible for a long time projecting from the end of the articulation, is described in the memoir upon the *Ophiuridæ* of the Adriatic.

In the Asterid-larva described by Busch, there is a prominent azygos process of the ambulacral canal; not however at the point of the arm, but on its ventral surface. This would appear to result from the position of the ambulacral canal of the As-

terids, which is superficial and uncovered by any hard structure. In the vermiform Asterid-larva which I have described, the cæcal extremities of the ambulacral canals project from the extremities of the arms, in which respect this larva agrees much more closely with the *Ophiuridæ* than with the *Asteridæ*. We are not yet acquainted with its earliest condition, and it is very desirable to ascertain whether its form resembles a *Pluteus* or a *Bipinnaria*. There is no evidence to enable us to say whether the terminal segment of its vermiform body should be referred to the anus or madreporic plate of the body of a starfish. If it were an *Ophiurid*, this segment must be considered as the remains of the dome of the larva.

The terminal articulation of the arm of an *Ophiura* is neither ambulacral nor purely anti-ambulacral, but as it were an osseous node, from which the ambulacral plates, the ventral and dorsal or anti-ambulacral discs, and the inter-ambulacral lateral discs take their origin. The terminal plate of the arm of the Asterid may be considered to be such a node. The ocellar plate of the Sea-urchin is the terminal plate of a radius whose antambulacral side is absent. In analysing the radii of *Dysaster* into a trivium and bivium, the genital plates, of which there are four, remain at the apex of the trivium; the ocellar plates however follow their radii.

#### Oral Skeleton of Echinidæ, Holothuriadæ and Ophiuridæ.

According to H. Mayer's elaborate analysis the oral skeleton of the regular *Echinidæ* consists of five pairs of *alveoli* for the five enamelled teeth, of ten *epiphyses* for the inter-connexion of the former, and of five other radial pieces upon which the epiphyses articulate. These are the pieces which Des Moulins calls *rotulæ*, Valentin *falces*. An additional suspensory apparatus of the oral skeleton is constituted by the five 'compasses' of Valentin, which have been shown by Mayer to consist each of two portions; they are present only in the regular Sea-urchins, and are totally absent in the *Clypeasteridæ*.

The two epiphyses of each pair of alveoli are, in the regular Sea-urchins, provided with processes, which in *Echinus*, &c., become united into an arch at the base of the alveoli; in *Cidaris* and *Echinocidaris* the processes are present, but no longer united into arches; in *Diadema* the processes of the epiphyses have entirely vanished. In the *Echini* therefore, the ten epiphyses form with the five rotulæ a continuous circle; in *Cidaris*, *Echinocidaris* and *Diadema* an interrupted one. In the 'Anatomische Studien über die Echinodermen' I have compared this circle with the

oral ring of the *Holothuriadæ*. The rotulæ or radii of the Lantern resemble those pieces of the calcareous ring in the *Holothuriadæ*, over which the five ambulacral canals pass outwards; in the Sea-urchins they have the same relation to the five ambulacral canals. The *Holothuriadæ* have neither alveoli nor teeth.

In the *Clypeasteridæ* the oral apparatus has exactly the same composition as in the regular Sea-urchins, with a somewhat different form of the epiphyses and rotulæ. That their oral skeleton possesses only the five pair of jaws, the remaining parts being wholly absent, as Agassiz states with regard to those genera described in his monograph upon the *Scutellidæ*, is true of no genus of this family. On the other hand, in all the genera of *Clypeasteridæ*, this apparatus consists of twenty-five calcareous pieces, viz. ten *semi-alveoli*, their ten articular *epiphyses*, and five *rotulæ*. The rotulæ of the Clypeasters were observed by Des Moulins, who, however, failed to find them in the other genera. Their form differs from that of the regular Sea-urchins, inasmuch as they are deep and disc-shaped; the ambulacral canal passes as usual beneath them and above the inter-alveolar muscles, to the circular canal. The articular epiphyses of the alveoli are connected with them by a joint, and they hold the alveoli sufficiently apart to prevent the ambulacral canal, which passes under the rotula, from being compressed by the action of the inter-alveolar muscles. In most genera of the *Clypeasteridæ* the epiphyses of the alveoli have almost the same form as the rotulæ, and are united by sutures with the alveoli. Des Moulins has not recognised the epiphyses, but Don Antonio Parra observed both the epiphyses and the rotulæ in *Clypeaster rosaceus*, stating that there are three small pieces between the alveoli:—"En la union de dos de estas piezas, por la parte superior, dexas un hueco en el que están calocadas maravillosamente tres piecitas, de figura de la pepita de un melón verde, èstas se designan por la fig. 8." (Descripcion de diferentes piezas de historia natural, Havana, 1787, p. 141.) So that the structure of the oral skeleton in the *Clypeasteridæ* was well understood in the last century, and long before that of the regular Sea-urchins.

The genera of the *Clypeasteridæ* all possess the same pieces, and are distinguished merely by the form of the alveoli and the position of their articulating surfaces, which in *Clypeaster* and *Arachnoides* are nearer the oral cavity, in the others are at the external angles of the jaws. In *Arachnoides placenta*, however, the rotulæ are remarkable for their excessive and unusual predominance in size over the epiphyses and the elevation of their bases above the alveoli, while the epiphyses are small and have the ordinary form. In *Lobophora* both the rotulæ and the epi-

physes are very depressed in correspondence with the flattening of the alveoli. Short thin muscles pass from the auriculæ to the under surface of the alveoli.

The teeth of the Clypeasters, which are fixed in the groove of the alveoli, are only naked at their outermost extremity, the rest being covered by a proper soft membrane which must be regarded as the sac-like matrix of the tooth.

In describing and figuring the teeth of a *Galerites* (Mem. Geol. Survey, Lond. Decade 3. pl. 8) Forbes expresses the opinion, that perhaps all *Cassidulidæ* have teeth. I have examined a specimen of *Echinoneus* which still retained its buccal and anal plates, and although dry had lost nothing from its interior. However I could find no teeth in the contained matters, which consisted only of coarse sand, small Gasteropod shells, and fragments of shells, such as we meet with in sea-sand, and which proceeded from the contents of the intestine.

The stellate gap in the skeleton above the mouth of the *Ophiuridæ* and *Asteridæ* is well known not to be the mouth, but its antechamber. The mouth itself is round and lies deeper in a membranous diaphragm. The anterior chamber is therefore comparable to the vestibule in front of the mouth of the *Holothuriadæ*.

In the *Ophiuridæ* the stellate gap above the membranous diaphragm is surrounded by twenty pieces, which are simply the most anterior ambulacral plates united with five pair of interambulacral plates. The anterior ambulacral plates are in pairs like all the others; they are as usual united with the following ambulacral plates by muscles and articulations, but their union with one another takes place not by suture but by a toothed joint, and is therefore moveable. These anterior ambulacral plates bound the open angles of the oral gap, while the interambulacral pieces correspond with its salient angles; the ambulacral plate is united with the interambulacral plate of the angle of the mouth by a firm suture. The union of the interambulacral plates constituting any one of the salient angles of the mouth takes place by a denticulation, which allows of motion by means of transverse muscles which approximate the crura of the open angle and unite the anterior ambulacral plates of two ambulacra. The external edges of the angles of the mouth are beset with calcareous papillæ towards the oral clefts—*papillæ marginales*—marginal papillæ of the oral cleft. Upon the vertical edge of the oral angle again, we find in many genera a multitude of papillæ, the *papillæ angulares* or papillæ of the oral angles (dental papillæ, Müller and Troschel); below these in the *Ophiuridæ* stand the dentiform labial plates, arranged in a vertical series, and which I denominate *palæ angulares* instead of teeth. Are these



oral angles of the *Ophiuridæ* and *Euryalidæ* to be considered as alveoli, and are they homologous with the alveoli of the Sea-urchins? In such case the alveoli of the Sea-urchins, which consist of two halves, and whose angles are also inter-radial in relation to the mouth, must be considered to be metamorphosed inter-ambulacral plates, separated by a great space from the plates of the corona, but connected by muscles with the auriculæ, and these alveolar muscles would be the analogues of the inter-vertebral muscles of the *Ophiuridæ*.

Important considerations, however, are opposed to this interpretation. On more close examination, the apparent analogy of the oral angles of the *Ophiuridæ* with the alveoli of the Sea-urchins completely disappears. In fact there exists upon the vertical obtuse edge of the oral angle, both in the *Ophiuridæ* and *Euryalidæ*, a peculiar azygos plate (*torus angularis*), upon which the papillæ angulares and the dentiform plates are seated. These azygos plates upon the oral angles are wanting in all *Asteridæ*; they would themselves have a claim to be considered analogous to alveolar plates, if the so-called dental plates of *Ophiuridæ* were to be regarded as true teeth. The five azygos alveolar plates of the *Ophiuridæ* in question, however, have no similarity with the conjugate alveoli of the Sea-urchins; nor have the dentiform plates or *palæ* of the *Ophiuridæ* more resemblance to the enamelled teeth of the Sea-urchins, since they exhibit the ordinary osseous structure. Furthermore, if we take into consideration the manner in which the *palæ* are inserted upon the plates of the oral angles, it clearly results that they are not teeth at all. They are in fact moveable and united with the angular plates by two muscles, which are inserted into deep excavations or perforations lying in pairs in these plates. These perforations in part pierce the *torus angularis* and extend as far as the bases of the oral angles. The other insertion of the muscles is into the upper edge of the base of the *palæ*, so that when they contract, the outer ends of the *palæ* are drawn upwards. They are doubtless used as manducatory organs. The papillæ angulares above the *palæ* are also moveable, but they possess no such muscles at their bases; the *Euryalæ* have only papillæ angulares on the plates of their oral angles, but no *palæ*. The peculiar plates at the oral angles of the *Ophiuridæ* are therefore to be regarded as bases of the lips to which the labial papillæ or *dentes spurii* are attached. The comparison of the oral angular plates (*tori angulares*) or most anterior inter-ambulacral plates of the *Ophiuridæ* with the alveoli of the Sea-urchins is therefore incorrect. This results also from other facts observable in the Sea-urchins themselves. In *Cidaris*, in fact, the corona is continued in the form of moveable ambulacral and inter-ambulacral

plates up to the mouth, so that even the series of feet are uninterruptedly continuous to the same extent. While in *Echinus* there is only a single pair of oral suckers between the corona and the mouth in the line of the ambulacrum, the series of moveable ambulacral plates of *Cidaris* terminate above the dental apparatus in the form of five lobes surrounding the mouth; they are distinguished from the angles of the mouth of the *Ophiuridæ* by being ambulacral or radial, while those of the *Ophiuridæ* are inter-radial. The dental apparatus of the Sea-urchins, therefore, is something peculiar which is not possessed by the *Ophiuridæ*.

There is in the latter an analogue of the calcareous ring of the *Holothuriadæ* which has hitherto been unnoticed, lying beneath the most anterior ambulacral plates and the oral angles, and affording a basis for further comparison. These parts become visible in an *Ophioderma*, *Ophiocoma*, &c., or in an *Astrophyton*, if the internal surface of the ambulacral skeleton,—that which is turned towards the abdominal cavity,—be examined. Here also we observe the nervous ring and the circular canal of the ambulacra; the ambulacral nerve and vessel pass at the oral end of the ambulacrum from above downwards over the most anterior ambulacral plates, so that they appear upon the under surface in the midst of the cleft of the anterior ambulacral plates; here each enters its ring. The nervous ring lies in a groove, which is excavated transversely upon the inner surface of the united plates of the oral angle. This groove, which is readily visible in all *Ophiuridæ*, is covered by the peculiar *peristomial* calcareous plates with which we are now concerned. The membranous ring which constitutes the proper mouth of the *Ophiuridæ* below the oral angles is strengthened at its circumference by these calcareous plates. As a rule, there are ten calcareous plates, which in the *Ophiuridæ*, however, constitute no complete ring; they are conjoined in pairs and lie upon the lower surface of the oral angles. In *Ophioderma* two additional plates occur where these two plates meet, one in front of and the other behind their junction. In *Ophiolepis ciliata* these peristomial plates are least obvious and may readily be overlooked; but, on the other hand, the circular canal of the ambulacral vessels is here most readily visible, and may be injected or inflated from the Polian vesicles.

The latter are disposed inter-radially close to the ab-oral edge of the peristomial plates. From the circular canal ten branches pass through little perforations of the most anterior ambulacral plates to the lower oral suckers, which are situated in the stellate cleft above the membranous oral disc.

In *Astrophyton* the two plates which lie upon the lower surface of the oral angle are united into a single one, but five additional azygos plates make their appearance which are absent in the

*Ophiuridæ*; they lie at the oral ends of the ambulacra in front of the pair of ambulacral plates, so that the nervous cord and ambulacral canal pass downwards between them and the first ambulacral plates. These also would appear to be parts of the oral ring, although their position is peculiar. The nervous circle of the *Asteridæ* is also placed beneath the oral angles at the circumference of the membranous oral disc, where likewise there is a groove; it lies upon the oral disc under the angles, and may be immediately discovered from without, by breaking them off. The circular canal of the ambulacral vessels has the same position as in the *Ophiuridæ*.

The torus angularis is absent in the *Asteridæ*; the angles themselves consist of a pair of inter-ambulacral plates,—the most anterior pair of adambulacral plates, in fact,—which are applied together to form an angle. Between every pair of ambulacra we observe upon the inner surface an azygos plate, which cannot be enumerated among the intermediate inter-ambulacral plates, and is therefore hardly to be compared with the inter-ambulacral discs on the ventral perisoma of the *Ophiuridæ*.

It appears to me to be exceedingly probable that the parts of the oral ring of the *Ophiuridæ*, here described, are the same as those which constitute the calcareous ring in the *Holothuriadæ*; those parts of the ring which lie in the direction of the radii to which the longitudinal muscles of the *Holothuriadæ* are affixed, and over which the branches of the circular canal pass to the ambulacra, being absent in the *Ophiuridæ*. The peristomial plates of the *Ophiuridæ* are then the analogues of those portions of the lantern of the Sea-urchins to which the alveoli are fixed.

The nervous cord lies invariably beneath the perisoma of the mouth and the oral angles; in *Holothuria*, under the perisoma of the mouth; in *Echinus*, beneath the perisoma of the mouth where it is continuous with the ambulacra; in the *Asteridæ* and *Ophiuridæ* also beneath the oral angles of the calcified perisoma. The nervous ring lies invariably close to the proper mouth; where there is a membranous oral disc, at its circumference, and always above the oral calcareous ring when this exists. The circular canal of the ambulacral vessels lies more or less deeply below the calcareous ring when this is present; in the *Echinidæ* the dental apparatus lies between the nervous ring and the circular canal.

The relations of the oral ring of the *Ophiuridæ* are perfectly different from those of the buccal plates of the Sea-urchins which cover the external surface of the oral membrane, as in the *Spatangidæ*\*, *Echinoneus*, and the regular Sea-urchins. These

\* In the *Spatangidæ* the mouth lies excentrically to the excavation of the corona and to the circular canal which surrounds its edge, and is close

are everywhere continuous with the plates of the perisoma, and either irregular and without suckers as in the *Spatangidæ* and *Echinoneus*, or partially ambulacral as in *Echinus* (the ten suckers round the mouth), or divided like the corona into inter-ambulacral and ambulacral plates with suckers, as in *Cidaris*. In the *Holothuriadæ* these plates upon the oral disc are absent, and the oral membrane in the *Ophiuridæ* also is naked.

[To be continued.]

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XIII.—Notes on the Ornithology of Ceylon, collected during an eight years' residence in the Island. By EDGAR LEOPOLD LAYARD, F.Z.S., C.M.E.S.

[Continued from vol. xii. p. 272.]

113. ORIOIUS MELANOCEPHALUS, Linn. *Ka-cooroolla*, Cing.; lit. Yellow Bird. *Mam-coel*, Mal.; lit. Mango Coel from its colour. Mango Bird and Golden Oriole of Europeans.

The Ceylon race of this common and widely distributed species differs from the Indian in having the tertiaries much less tipped with yellow; nor is this an accidental circumstance, but constant in every one of the many specimens I have examined. It may not be amiss to mention here that many of our island species differ in some degree from their continental brethren, though perhaps not sufficiently to constitute distinct races. Mr. Blyth, whose great experience in Indian ornithology enables him, perhaps better than most, to judge of these gradations of colour and size, early noticed the peculiarities of our fauna in our correspondence, and I cannot do better than give his own words on this subject\*. "Others," says he, "are doubtfully distinct, as *Megalaima zeylanica* from *M. caniceps* of S. India; *Leucocerca compressirostris* (J. A. S. B. xviii. 815) from *L. albofrontata*; and we might have here placed *Malacocercus striatus* as

to the posterior lip-like edge of the excavation. The anterior lip is not formed by the opposite edge of the shell, but by the plated buccal membrane.

\* The late lamented Mr. Strickland was so much struck with these differences, that at his request the publication of these "Notes" was suspended until we might together go over a series of Ceylon killed specimens and compare them with examples from India and the Indian Archipelago. I am not sorry for the delay, since it has enabled me to add several species new to the fauna of Ceylon which have been received from Mr. Thwaites of Peradenia within the last two months; but I have been deprived of the invaluable notes and remarks promised me, and which would have rendered these memoranda of much use to the naturalist, by the untimely death of my learned and accomplished friend.